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CYBERNETICS AND THE AUTOMATIZATION OF PRODUCTION

- USSR -

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(We are answering the questions of journal readers V. M. Potak of Feodosiya, A. A. Paratsevich of Ul'yanovsk, and others.)

In the present period of important discoveries in the field of the physical and chemical sciences, of the powerful, indeed, revolutionary, development of technology, the significance of automation has grown tremendously. Today the level of the development of our science and technology is such that there is every opportunity to realize a broad automatization of production and to initiate the reorganization of technological processes on the basis of complete automatization.

The accumulated scientific and technical experience in the field of automation permits foreseeing a future which is actually not far away. And what a future! There will be factories in which the entire technological process will be carried out under the most advantageous conditions by a group of automatic machines; mines in which there will be virtually no workers below ground; computers performing the work of accountants, helping to plan the economic life of enterprises, cities, regions, and of the entire country on the basis of the calculation and processing of a huge quantity of information; interplanetary flights of cosmic ships controlled by automation.

This is what the automation plant will probably be like. There will be no people By the machines, which will be separate cells of a single productive mechanism. A central electronic-control machine will control the entire cycle of production. It will perceive all the diverse information concerning the plant, and observe the machine tools and the shop's individual electronic-control machines. The latter will be equipped with a sufficient number of responsive (sensitive and executive) elements and memory devices which will provide automatic control of the machine tools and other mechanisms in the shop.

The central machine will possess a special type of sensitivity to the effects of the external environment. For example, it will receive production orders, take into account the technical characteristics of raw materials and semifinished goods, check the quality of the articles produced, and, moreower, in proportion to the accumulation of experience, continuously perfect the production technology.

The central machine, operating in accordance with an established program, will be able to include in the production process any of the shop machines for the automatic execution of operations assigned to it in the presence of changes of the external environment. These operations will be attentively "memorized" by the central machine. As a result, certain of the shop machines--the automatic "shop foremen"--will cease functioning, but, not having passed a test, will be subjected to changes in design and repeated tests. The selected automatic "assistants" of the central control machine will begin to act in accordance with the production program of the plant.

What will the central machine controlling the production activity of the plant be like? It will consist of three units: the recognition control unit, the systematization (planning) control unit, and the control execution unit.

First of all, the recognition control unit will study the characteristics of the controlled object (here, the automation-plant). It will not be sufficient to observe the operationof the plant only passively; the recognition unit must act upon the object, experimentally check its properties, and, in addition, evaluate the required technical characteristics. This, in its own way, will be the perceptive effect or "battle reconnaissance."

After the recognition block reaches a definite stage in the investigation of the unit, the next stage begins--the systematization control of the plant's production activity, which will be accomplished by the systematization control unit. And at this stage, the specification of the properties of the control object may be required, which will be realized by way of counter-inquiries of the systematization control unit and the recognition control member. After the development of a more acceptable production-finance plan, the systematization control unit, by means of the control execution unit, will actually begin to control the productive activity of the plant by means of its own "shop helpers" of which we spoke earlier.

Thus one can foresee for the future the operation of an automation-plant equipped with controlling devices. Already at the present time automatic-control devices and systems are being developed which are able to "supervise" complex production processes, to draw up, project, and interpret technical themes.

What then is the role of cybernetics in the creation and utilization of such devices? Before answering this question, let us clarify cybernetics.

Cybernetics is the science concerning the general principles of control processes. Increasing the efficiency of man's activity in all areas is its goal when it is necessary to bring about control. The concept of cybernetics comes from the Greek word "kibernos," which denotes the art of steering (of helmsmanship). The American mathematician N. Wiener introduced this science. The control of a ship, during which the task of the helmsman is to coordinate rudder movements, depending on external conditions, can serve as an approximate representation concerning the substance of cybernetics. Cybernetics is concerned with the investigation of objects able to receive, convert, and store any information and to utilize it for control.

The information, for example, is transmitted by speech or by means of books, papers, or journals. It is contained in the readings of measuring devices or in the signals entering the input of automatic-control devices. In objects in which the process of control occurs, independent of what these objects are, there are two forms of activity: information activity, resulting in the reception and transmission of information; and execution activity, requiring the expenditure of energy. Consequently, in any control unit there are two systems: signal and energy. However, although both these systems are closely related, the expenditures of energy accompanying the transmission of signals in the control processes occupy a secondary place. For example, of first importance to the owner of a television set is the quality of the transmitted image and not the efficiency of the television. That is, the television set is intended to yield not energy, but information--information in the form of signals.

Another important problem of cybernetics is associated with self-adjusting devices. These devices can be considered as simulators of a living organism. In practice, this is the most highly perfected system of automatic control. Cybernetics establishes general rules to which are subordinate certain phenomena of mechanisms and organisms. Such a comparison of an organism with a mechanism, in particular one with automatic devices, permits perfecting and resolving more efficiently the problems of the substitution of the functions of man in production.

As is well known, in living organisms there exist quite ideal organs which control blood pressure, body temperature, and other characteristics which assure the active life of the organism. Created by nature, these organs possess the capability of self-adjustment, that is, automatic variation of the control process depending on changes in external conditions. Technology has still not created self-adjusting automatons as perfect as the automatic organs of the human organism. However, definite progress in the creation of self-adjusting automatons has already been achieved. At the present time, automatic self-adjusting devices have been developed which can be considered as embryonic elements of the cybernetic machines of the future.

For example, at the Moscow pipe plant, a self-adjusting automaton has been installed for controlling the welding processes of electro-welded pipe mills. In the manual control of such a mill, seam welding is not always well done. To achieve good results in manual welding is very difficult, since in the welding process the temperature of the welded seam depends on many factors, for example, on the thickness of the metal. A self-adjusting system, continuously measuring the thickness of the material coming into the mill and the temperature of the welded seam, performs a statistical analysis of these two parameters and by means of computing devices determines and provides the most efficient welding systems. The economic effect of the application of such a system in only one plant is a saving of 5 million rubles per year. Similar systems can also be used in mills for the hot rolling of steel. Here, depending on the results of the first rolling, the adjustment of the rolling control system is automatically made more precise.

The structure of control (cybernetic) devices and their application in production permits converting a huge quantity of information. However, the great German physicist Einstein said that although a machine may be capable of solving any problem whatsoever, it is never capable of setting up even one. This means that if one again turns to the example of the above-considered control machine, the word "recognition" can stand only in quotation marks in its application to an operation. In actuality, it is not the control machine will will perceive but man. But equipped with machines for automatic control, it solves problems which cannot be solved without machines.

The design of any automatic machine controlling any automatic process inevitably includes in itself as the central link--man, the creator of this machine. Man will not directly participate in the work of the automatized plant, but he will build this plant and install in the machines an operational program which controls the regular production process of the plant. To paraphrase Marx, they are the products of human industry, created by human hands and the human brain.

Such a machine, independently of the efficiency of its given characteristics, for example, the capability to respond correctly to chance variations in the external environment not previously foreseen or of its capability to spontaneously reproduce like machines, is nonetheless a machine.

Discussions appearing in the foreign technical and philosophical literature concerning the ability of a cybernetic machine to think and sense similarly to man is the result of the groundless confusion of technical questions with the philosophical gnosiologic question concerning the relationship of subject and object.

From the aforesaid it follows that the gradual and purposeful development of cybernetic problems is a necessary condition of the fruitful development of today's technology and that of tomorrow.

Under the Soviet system, which is based on more progressive forms of controlling the national economy, cybernetics is considered as a service to society for the development of methods for improving the organization of production and for controlling the national economy, productive processes, and economic activity, and also for the development and utilization of technical means for the realization of these methods.

Cybernetics promotes a more rapid and perfect fulfillment of the resolutions of our Party concerning the broad introduction of complex mechanization and the automatization of production processes, of the construction of highly efficient automatized complexes(plants, shops, installations) in various branches of the national economy. Moreover, it promotes the creation of the material-technical base of Communism, and the achievement of an immeasurably higher labor productivity than is possible under capitalism.

Automatization opens great perspectives and has decisive significance for the technical progress of our country. Automatic production complexes are acquiring at the present time the same role as operating machines played in the industrial revolution of the 18th century.

The main effect of automatization will be exerted through the general reorganization of industry. Automatization will be the basis of production control, it will make it possible to reconstruct it radically, to convert from separate units to production complexes, to shops and plant automatons which in the long run will provide the highest labor productivity. The creation of automatically controlled production will be the most representative feature of the coming period of technical development in all branches of our industry.

The wide automatization of production through the building of Communism will radically change the character of labor and will assist in raising the cultural-technical level of the workers and peasants. Marx wrote that the reduction of working time is a most important condition of the true freedom of humanity. The results of automation are precisely expressed in the reduction of the working day, and consequently in the increasing of free time of the workers, in the development of their physical and artistic forces, in the enrichment of the spiritual world, and in the multi-sided development of their endowments and talents.

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